S12b Growing supermassive black holes through secular processes: a machine learning approach to identifying substructures in quasar host galaxies with HSC

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Background: How do quasars form and which galaxies are most nurturing for quasars? It has been demonstrated that galaxy mergers play a role but these can not explain the full observed population of quasars. Data-driven techniques and machine learning are a promising avenue towards understanding the morphological differences between galaxies with and without quasars.

Methods: We use Hyper Suprime-Cam data to produce residual images showing the substructure of the galaxies. We use a variational auto-encoder (VAE) with these residual images as our training data. The VAE performs dimensionality reduction by encoding the 40 by 40 pixel images in a 5 dimensional latent space. This lower dimensional latent space can be analyzed to see if the galaxies with quasars are distributed differently from the galaxies without quasars.

Results: We find that the VAE can distinguish between galaxies with quasars and galaxies without quasars. It finds that galaxies with quasars tend to be located in a region of the latent space associated with extended structure, spiral arms, and bars. Galaxies without quasars tend to be located in regions of the latent space that show more compact and symmetrical structure.

Discussion: Our results show that the difference between galaxies with quasars and without occurs on an observable scale and that spiral arms and bars may be correlated with the existence of quasars.